CHAPTER

8

INTERNETWORKING WITH NOVELL NETWARE

After reading this chapter and completing the exercises, you will be able to:

- Discuss connecting Windows 2000 Professional computers to NetWare servers
- Install and configure NWLink
- Install and configure Client Service for NetWare (CSNW)

Although Microsoft has positioned Windows 2000 as the replacement for other network operating systems, it is necessary to provide connectivity to other systems for compatibility. For this reason, Microsoft provides numerous utilities, applications, and protocols for connecting to various types of computers. In this chapter, you explore connecting Windows 2000 Professional computers to Novell NetWare networks.

NetWare Networks

Novell NetWare is designed for file and printer sharing on a network. Because it was one of the first true network operating systems, NetWare garnered a substantial and loyal following throughout the late 1980s and early 1990s. By the mid-90s, NetWare servers functioned as the backbone for more networks than any other type of server on the market. The most recent iteration of NetWare is NetWare 5. With the growth of PC capabilities and the advent of the Internet, NetWare has adapted and expanded to provide robust services, while maintaining its solid file and printer sharing performance.

Although Windows NT and Windows 2000 servers account for a growing number of network servers, a large number of companies around the world rely on Novell NetWare for their server requirements. For this reason, Microsoft includes interconnectivity enhancements to allow Windows 2000-based computers to connect to and function with NetWare servers. These enhancements include NWLink, Client Service for NetWare, File and Print Services for NetWare, and Gateway Services for NetWare. Of these, only NWLink and Client Service for NetWare are used by Windows 2000 Professional systems. File and Print Services for NetWare and Gateway Services for NetWare are used by Windows 2000 Server computers.

Beginning with version 1.0, NetWare utilized the **bindery**, which is a proprietary database that contains all network resource information, such as user and group names, print server settings, and file server configurations. With NetWare 4.0, Novell introduced **Novell Directory Services (NDS)**. NDS is the hierarchical database used by NetWare 4.0 and higher servers to store network resource object configuration information, comparable to the function of Active Directory in Windows 2000. With this introduction, Novell began the era of object-oriented directory services. In this context, a directory is a dynamic database that contains information for network objects such as printers, applications, and groups. Later sections of this chapter discuss the differences between connecting to bindery (pre-version 4.0) servers and NDS servers.

Windows 2000 Professional and NetWare

Because the Professional edition of Windows 2000 is designed to operate as a network client, it includes features that enable it to connect to a variety of network servers, including NetWare servers. Because both bindery and NDS servers are in use today, Windows 2000 is able to connect to both types. Once connected, the Windows 2000 Professional computer utilizes resources on the NetWare server as if they were actually on a Windows 2000 server. In this manner, all network resources are accessed through the same method, making a heterogeneous network appear seamless to network users.

NetWare Compatibility Components

There are two main components that facilitate Windows 2000 Professional compatibility with NetWare servers: NWLink and Client Service for NetWare. The next sections discuss installing and configuring these components.

NWLink

Like many network operating systems developed in the 1980s, Novell found that the available protocols were not sufficient to support the demands of its new product. To fit their needs, the developers at Novell produced a protocol suite based on the Xerox Network System (XNS) protocol suite. XNS was developed during the creative networking heyday of the early 1970s at Xerox's Palo Alto Research Center (PARC). PARC is also responsible for many areas that form the foundation of today's computing environment, including client/server architecture, Ethernet, laser printers, the first commercially viable mouse, graphical user interfaces, and HTTP, the protocol of the World Wide Web. PARC is still operating today and is one of the most fascinating stories in computing. For more information on PARC's contributions to computing, visit the PARC Web site at *http://www.parc.xerox.com*.

The developers at Novell determined that, although XNS formed a solid foundation for their network protocol suite, it was not robust enough to accommodate the required communications between networked PCs. Novell modified XNS to create the **Internetwork Packet Exchange/Sequenced Packet Exchange (IPX/SPX)** protocol suite. **IPX** is a connectionless protocol that provides quick network transport for most of the communications on a NetWare network. Because it is connectionless, IPX does not guarantee packet delivery, but it is generally sufficient for network communications. **SPX** is a connection-oriented protocol that provides guaranteed packet delivery. However, because it is connection-oriented, it requires higher overhead and is slower than IPX. For this reason, SPX is used in NetWare communications for only certain applications, such as those that manage the server's console.

NWLink is Microsoft's implementation of the IPX/SPX protocol suite and can communicate with all NetWare implementations. Novell and Microsoft approach networking in a slightly different manner, meaning that the underlying architecture of each company's network communication is different. Novell's specification is called **Open Datalink Interface (ODI)**. Microsoft's architecture is called the **Network Device Interface Specification (NDIS)**. Strictly speaking, IPX/SPX is ODI-compliant, but not NDIS-compliant. NWLink is the NDIS-compliant implementation of IPX/SPX.

Installing NWLink

Like all networking components of Windows 2000, NWLink is installed through the Network and Dial-up Connections applet of the Control Panel. To run this applet, select Settings from the Start menu, then select Control Panel. Once the Control Panel is opened, double-click Network and Dial-up Connections. The same applet can be initiated by right-clicking the My Network Places icon on the Desktop, or directly from the Start, Settings menu. Figure 8-1 shows the Network and Dial-up Connections dialog box.

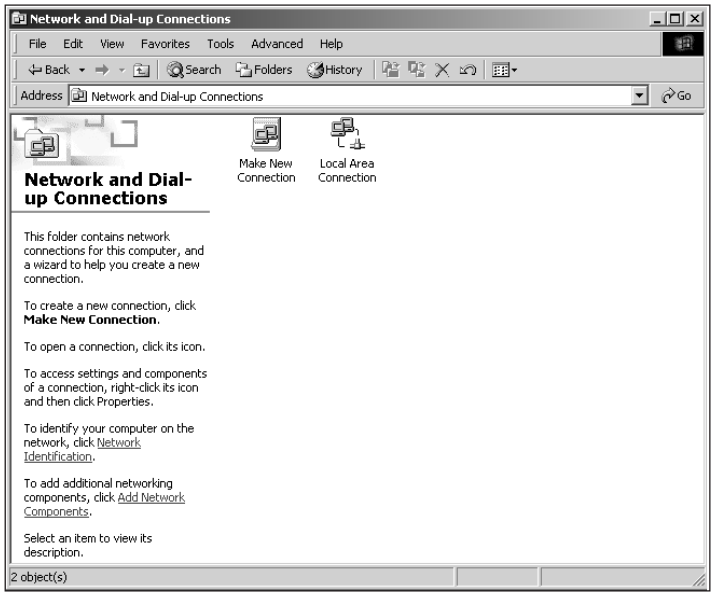

Figure 8-1 The Network and Dial-up Connections dialog box

Displayed in the dialog box are icons for each of the connections currently configured on the computer. On the computer shown in Figure 8-1, only a Local Area Connection has been configured. If a dial-up connection or a secondary network connection had previously been installed on the computer, its icon would be displayed in the dialog box as well. Simply double-clicking the icon for the Local Area Connection displays the Local Area Connection Status dialog box, shown in Figure 8-2. This dialog box provides, at first glance, the number of packets sent and received, as well as the status, speed, and duration of the connection. The Disable button prevents the connection from being used. Double-clicking the outline of the connection reenables the connection.

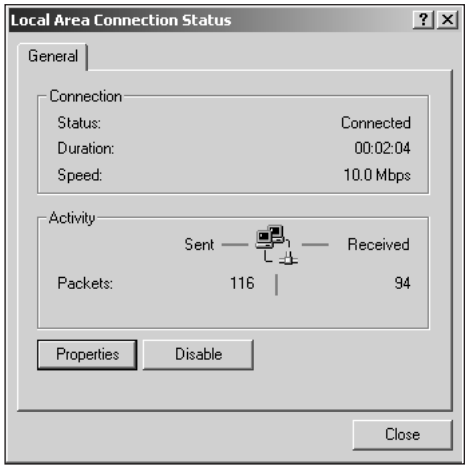

Figure 8-2 The Local Area Connection Status dialog box

Clicking the Properties button brings up the Local Area Connection Properties dialog box. It is through this dialog box that all networking components are added to Windows 2000. If the Typical installation option is selected during the Windows 2000 installation process, Client for Microsoft Networks, File and Printer Sharing for Microsoft Networks, and Internet Protocol (TCP/IP) are loaded by default, as shown in Figure 8-3.

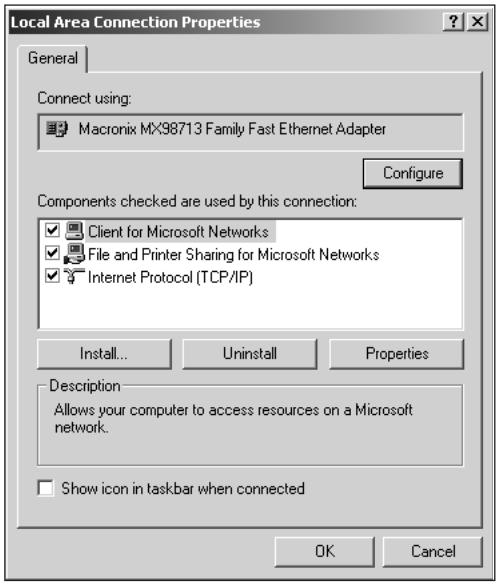

Figure 8-3 The Local Area Connection Properties dialog box

To connect to a NetWare network, the NWLink protocol must be loaded. To add a new networking component to the Local Area Connection, click the Install button. You are presented with the Select Network Component Type dialog box, which allows you to install a Client, Service, or Protocol. Because NWLink is a protocol suite, select Protocol, and click Add. In the Select Network Protocol dialog box, you are able to select from the available protocols not yet installed on the computer. If TCP/IP is the only protocol installed, the list includes the following: AppleTalk Protocol, DLC Protocol, NetBEUI Protocol, Network Monitor Driver, and NWLink IPX/SPX/NetBIOS Compatible Transport Protocol. The protocols other than NWLink support many different networking devices and are discussed in other chapters. To continue with the installation, select NWLink IPX/SPX/NetBIOS Compatible Transport Protocol from the list and click OK. After a brief moment for configuration, you are again presented with the Local Area Connection Properties dialog box, as shown in Figure 8-4. To complete the installation of NWLink, click Close on the Local Area Connection Properties dialog box. (Complete steps for installing NWLink are given in Hands-on Project 8-1.)

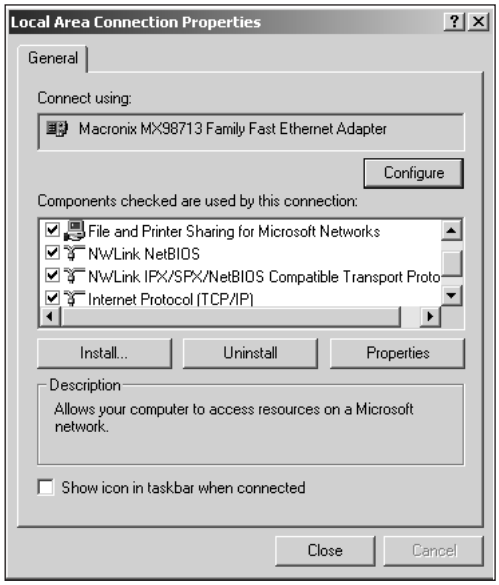

Figure 8-4 The Local Area Connection Properties after adding NWLink

Note that in addition to the NWLink IPX/SPX/NetBIOS Compatible Transport Protocol, the NWLink NetBIOS protocol has been added. Just as Novell's networking model is built on the XNS protocol suite and networking system, Microsoft's networking architecture was built on existing technology. Microsoft's first steps in the networking arena were in a partnership with IBM on the LANManager product. LANManager used the **Network Basic Input/Output System (NetBIOS)** for network naming and transport. As Microsoft developed its own networking strategy, it kept the NetBIOS naming system. All Microsoft networking implementations must be NetBIOS-compliant to provide interconnectivity. Because IPX/SPX is not NetBIOS-compatible, NWLink includes an additional protocol to provide this functionality.

Configuring NWLink: Ethernet Frame Types and IPX Network Numbers

After installation is complete, NWLink has two configuration options available: Ethernet frame types and network numbers. Ethernet can utilize four **frame types** supported by NWLink: Ethernet 802.2, Ethernet 802.3, Ethernet II, and Ethernet SNAP. A packet's frame type defines the structure of the packet and the fields that are included. For example, one frame may put the packet components in order of header, source computer, source network, destination computer, destination network, checksum, and data. A different frame's order may be header, destination network, destination computer, source network, source computer, data, and checksum.

It is very important for all computers communicating on the network to use the same frame type to ensure that communication takes place. If frame types do not match, communication is not possible.

By default, as shown in Figure 8-5, Windows 2000 determines the frame type being used on the network and configures itself accordingly. It does this by accepting the first NWLink packet it receives and using the same frame type. If all computers on the network are set to Auto Detect, the Ethernet 802.2 frame type is used because it is the accepted industry standard.

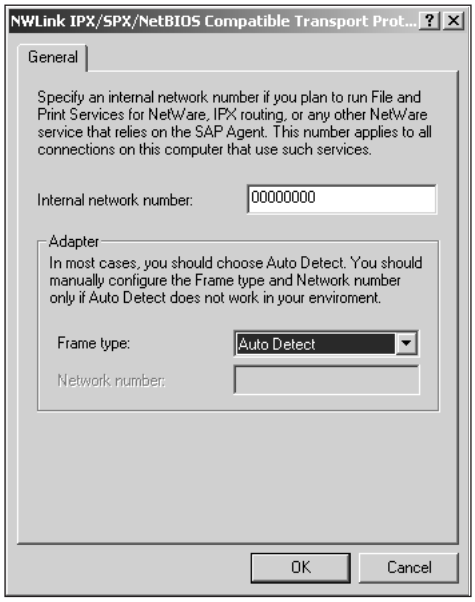

Figure 8-5 The NWLink Properties dialog box

Unless there is a specific reason to use a different frame type, it is best to let Windows 2000 detect the frame type being used on the network. By doing so, potential problems caused by frame type mismatches are eliminated. However, if it is necessary to specify the frame type being used by the computer, select the appropriate frame from the Frame type drop-down list in the NWLink IPX/SPX/NetBIOS Compatible Transport Protocol Properties dialog box. When a frame type other than Auto Detect is selected, you must specify the **network number** (the network and computer identifier) used by the frame type.

Like TCP/IP, NWLink (IPX) makes a distinction between the computer ID and the network ID on which the computer resides. However, unlike TCP/IP, the computer ID and network ID, or network number, are separate fields in IPX. When the computer is configured to automatically detect the frame type used on the network, it is also able to determine the

network number from the frames it receives. However, when a specific frame type is selected, you must also specify the network number to which the computer is attached. To ensure that this information is accurate, check with your network administrator before changing the frame type. If the network number does not match the network number used by other computers on the network, your system will not be able to communicate.

Network numbers on IPX networks are not limited to numerals. Because IPX translates the network numbers from hexadecimal to binary, it is able to support the letters A through F in its network number field. This makes it very easy to ensure unique network numbers on large networks. It also gives the network administrator an opportunity to be creative. For example, a network number 1B0001 could be used to indicate the first network on the first floor of Building B. Then again, a network number of BAD4DAD is both descriptive and fun.

Refer back to Figure 8-5. Note that there is also an option at the top of the dialog box for the Internal network number. Part of the design of IPX utilizes a network number assigned to the internal operations of the computer. Under most circumstances, it is not necessary to change this number. However, if the network number that is assigned to the internal network number is in use elsewhere on the network as a normal network number, communication will be sporadic and very difficult to troubleshoot.

Client Service for NetWare

The **Client Service for NetWare (CSNW)** component of Windows 2000 Professional allows a Windows 2000 computer to access resources on NetWare servers version 2x, 3x, and 4x. CSNW supports full access to NetWare file and print servers, NetWare utilities, bindery connections, and some NDS connections.

The version of CSNW that is included with Windows 2000 Professional is not compatible with all features of the NetWare 5.x version of NDS. CSNW allows authentication to NetWare 5.0 NDS-enabled servers, but to allow full functionality, you must load the client software provided with NetWare.

File and Print Servers

To provide access to NetWare file and print servers, CSNW adds a new NetWare-focused redirector that acts as an extension of the file system, in much the same way that the native redirector supports access to Microsoft Windows 2000 and Windows NT servers. (Redirectors handle transmission of remote requests across the network so that the requests are filled.) The difference is that CSNW implements **NetWare Core Protocol (NCP)** requests for file and print services, whereas the native redirector uses the **Common Internet File System (CIFS)**, an enhanced version of the **Server Message Block (SMB)** protocol. Both NCP and SMB perform the same functions, but provide access to different file systems.

Once CSNW is installed, the Windows 2000 user is able to use a single logon to attach to all resources on the network, regardless of the server hosting the resources. In a NetWare-only environment, only CSNW is active and it provides access to the resources. However, in a mixed NetWare/Windows 2000 or Windows NT environment, the appropriate client software is used, depending on the type of server being accessed. (Installation of CSNW is covered in a later section; complete steps are given in Hands-on Project 8-2.)

Supported NetWare Utilities

To ensure proper desktop integration in a NetWare server environment, CSNW supports most NetWare utilities and functions. It provides access to character-based NetWare administration utilities such as SYSCON and PCONSOLE. Many of the utilities are dependent on the versions of NetWare in use. Versions 3.12 and lower support only character-based applications, whereas versions 4.0 and above utilize mainly GUI-based applications. However, even in NetWare 5, some character-based utilities can be used to manage the server environment.

By default, NetWare versions before 5.0 do not support the long filenames supported by Microsoft products such as Windows 2000. To ensure that the Windows filenames are not truncated when they are copied to NetWare servers, the servers must load the OS/2 name space. This is done on the NetWare server itself and ensures that all files retain their settings when stored on the server.

NWLink and CSNW also support IPX burst mode, which enhances bulk data transfer over an IPX network. By design, IPX is best suited to handle small to medium-sized packets and many network communications. When tasked with transferring large amounts of data, IPX loses efficiency and creates excessive network traffic. Burst mode allows routed network connections to negotiate the largest possible packet size so that fewer packets must be sent to transmit large data files. This improves bandwidth utilization and reduces overhead on the network.

Bindery and NDS Support

To effectively ensure that client computers can attach to any server on the network, Client Service for NetWare includes support for both bindery and Novell Directory Services servers. As mentioned, versions of NetWare prior to 4.0 utilized the bindery to store their configuration information, including user and group lists, printers, and security settings. When users log on to a bindery-based NetWare server, they access the bindery for logon authentication, confirmation of security authorizations, group memberships, and so forth. One of the primary limitations of bindery-based NetWare is that each server on the network has its own bindery. Users that access resources on multiple servers are required to log on to each server individually.

Beginning with NetWare 4.0, Novell utilized the Novell Directory Services (NDS) database to store and maintain the information previously stored in the bindery. The NDS database is much more dynamic and supports enterprise-wide networks. The NDS database is a hierarchical tree that is stored on many servers on the network to provide single-logon access to resources.

In addition, centralized administration and resource management is possible with NDS—a dramatic improvement over administering earlier versions of NetWare.

Because NDS is a hierarchical database that can be stored on multiple servers on the network, an NDS implementation resembles a tree and is referred to as the **NDS tree**. At the base of the tree is the Root object, which generally represents the largest organization connected to the network, often the entire corporation. Working down through the tree, each department may have a container, then each group within the department may have another container. In NDS, each network resource, whether a user, group, file server, printer, or storage area, is represented as an object. Objects are stored in containers representing their function on the network. A network object's location in the NDS tree is called its **context**. Figure 8-6 is an example of what an NDS tree might look like.

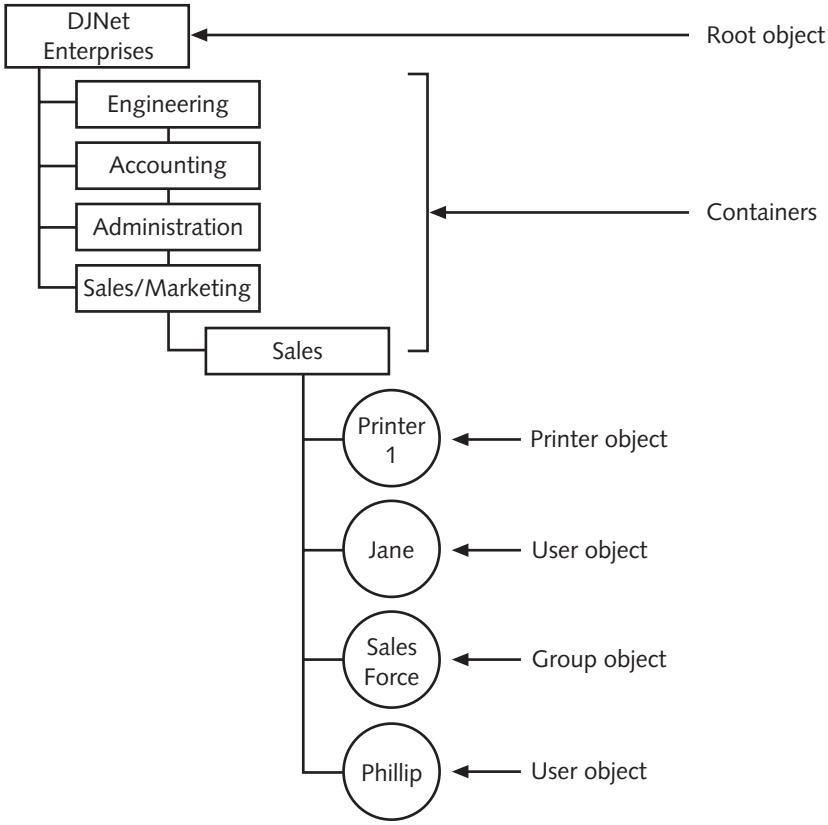

Figure 8-6 An example of an NDS tree structure

In the example shown in Figure 8-6, the Phillip user object is stored in the Sales container, which is in turn stored in the Sales/Marketing container, which resides under the DJNet Enterprises Root object. The context for the Phillip user is DJNet Enterprises.Sales/Marketing.Sales.

Installing and Configuring Client Service for NetWare

Like NWLink, installation of Client Service for NetWare is accomplished through the Local Area Connection Properties dialog box. To begin installation, right-click My Network Places and select Properties. When the Network and Dial-up Connections dialog box opens, right-click the Local Area Connection icon and again select Properties. Click Install; you will be asked to whether to install a Client, Service, or Protocol. As its name implies, Client Service for NetWare is a client component. Select Client and click Add. If the default configuration is installed, the only client available for installation is CSNW. Ensure that Client Service for NetWare is selected and click OK to continue the installation. Once installation is complete, you will be asked to restart your computer. You must do so before CSNW can be used. Click Yes to reboot your computer.

Client Service for NetWare relies on NWLink to operate. If NWLink is not loaded when CSNW is installed, it will be installed automatically.

Assigning a Default Tree and Context Using CSNW

After the computer has restarted, you will be presented with the Select NetWare Logon dialog box, shown in Figure 8-7. It is through this dialog box that you assign the default NetWare tree and context on the NDS-enabled NetWare network to which the Windows 2000 Professional computer will be connecting. Unlike most areas of Windows 2000, you are not able to browse for the tree and context. You must have this information available to type into the dialog box. If this information is not available the first time the computer is restarted, you can click Cancel and enter the information later.

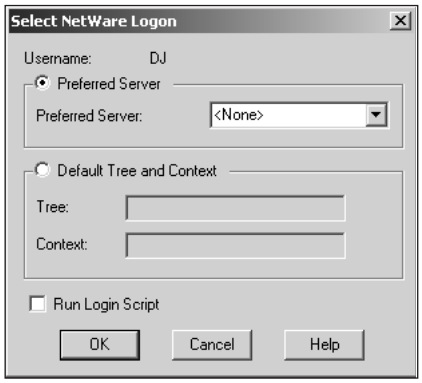

Figure 8-7 Use the Select NetWare Logon dialog box to configure the default tree and context

Unlike many networking components, CSNW is not configured through the Local Area Connection Properties dialog box. When CSNW is installed, a separate utility is placed in the Control Panel, and represented by the CSNW icon. If at any point you need to change the

default tree and context settings, or any CSNW settings, double-click the CSNW icon to access the Client Service for NetWare configuration dialog box. When accessed by this method, additional configuration options are available, which will be discussed in later sections.

Preferred Server vs. Directory Tree

In the event that you are connecting a Windows 2000 Professional computer to a bindery-based NetWare server, you will need to utilize the Preferred Server configuration options available in the Select NetWare Logon dialog box (refer to Figure 8-7). Unlike the Default Tree and Context settings, where you have to manually type in the tree and context, clicking the down arrow next to the Preferred Server box displays a list of the servers advertising themselves on your network. From the list, select the name of the NetWare server to which you are attaching. You can also directly enter the server's name in the Preferred Server box. If this method is used, be sure the server's name is spelled correctly. If an incorrect server name is entered, the dialog box shown in Figure 8-8 will be displayed, informing you that you could not be authenticated on the selected server because the network path could not be found. Clicking No returns you to the Select NetWare Logon dialog box, whereas clicking Yes accepts the configuration.

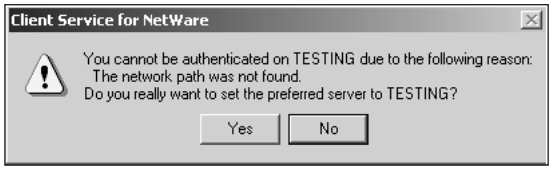

Figure 8-8 A Client Service for NetWare configuration error

Regardless of the configuration changes you make, a dialog box is invoked notifying you that the changes will take effect the next time you log in. Click OK to continue. The computer must be restarted manually, because the configuration program does not automatically restart the computer after the dialog box is closed.

Other Configuration Settings

When the Client Service for NetWare applet is used to configure the networking components, configuration options are available that are not presented when the client is first installed. As shown in Figure 8-9, these options make up the bottom half of the dialog box, in the Print Options and Login Script Options section.

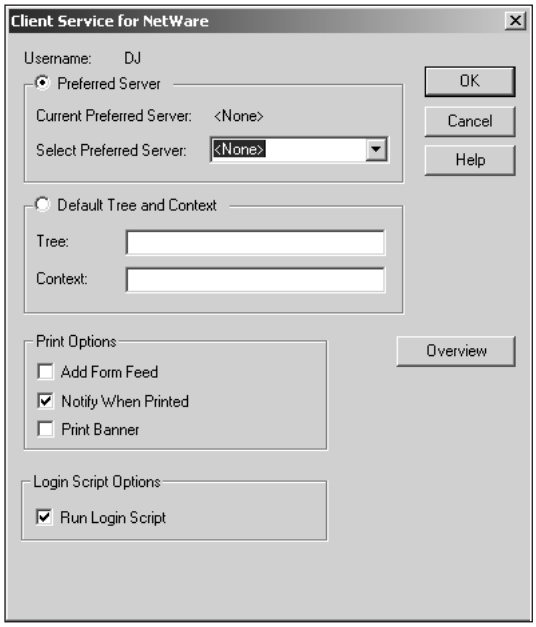

Figure 8-9 Client Service for NetWare configuration options

The settings available in the Print Options section determine whether the computer will send a form feed command to the printer when the print job is finished, send a notification message to the user when the print job is complete, or print a banner before the print job itself. Form feed commands are generally necessary only on older printers, usually those that use tractor-feed paper; most laser and inkjet printers do not require form feed commands after the job. If this option is used on a laser printer, for example, a blank sheet of paper is ejected from the printer after the job. Many users in a networked environment are not within eyesight of the printers they are using. For that reason, the Client Service for NetWare can be configured to send a network notification to the user after the job is complete. If this option is selected, a pop-up box appears on the user's computer when their print job is done. The banner page is also used in many larger networks. A banner page identifies the user that initiated the print job and the name of the job. In this way, users can easily identify their print jobs when they go to pick them up from the printer.

When the Run Login Script option is selected, the computer runs the NetWare logon script specified for the user by the administrator. This preserves the logon scripts that network administrators have developed for their clients and provides easy, centralized administration on all client computers. This is especially important to ensure client standardization, regardless of the client type. However, many of the functions that have been performed by logon scripts are now handled by Windows 2000 functions such as Map Network Drive. As client computers are converted to Windows 2000 Professional, it may no longer be necessary to utilize logon scripts, and this option can be disabled.

Note that Novell uses the terms "log in" and "login," whereas Microsoft uses "log on" and "logon."

Connecting to NetWare Resources

Because Client Service for NetWare integrates so closely with Windows 2000, connecting to NetWare resources is accomplished in the same manner as connecting to other resources. Most often, this is accomplished through My Network Places. In an NDS environment, if the resources to which you are connecting are in the same NDS tree, your initial logon provides you access to available resources. However, on bindery-based networks, you must log on to each server to access the resources on that server. Once you have logged on to the appropriate server or directory tree, the NetWare security system determines whether you should be granted access to the requested resources.

Through the Computers Near Me icon in My Network Places, you can connect to resources on servers or trees to which you have already logged on. To search for other servers or NDS trees, double-click the Entire Network icon, and click the *entire contents* link shown in the lower-left corner (see Figure 8-10).

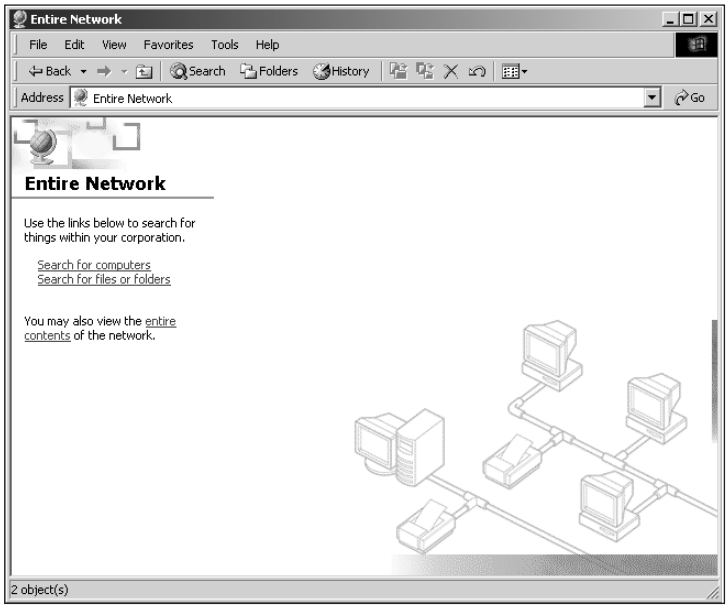

Figure 8-10 Select the entire contents link to search for additional NetWare resources

After clicking on the link, you will be presented with icons for each type of client installed, usually Microsoft Windows Network and NetWare or Compatible Network. To browse for additional NetWare resources, double-click the NetWare or Compatible Network icon.

NetWare-Aware Applications

In many cases, clients utilize network servers strictly for file storage and print functions. However, applications are being designed more and more to operate in conjunction with the network server. These types of applications are true client/server applications, utilizing the processing power of the server for CPU-intensive functions, and performing more simple tasks on the client workstation.

Applications designed to interact in this manner with NetWare servers are referred to as "NetWare-aware." To operate correctly, these applications must function without regard for the underlying operating system. CSNW provides the resources that NetWare-aware applications need to operate.

However, there are some NetWare utilities that are not compatible with CSNW; these are utilities designed for DOS connection to NetWare servers and are not needed in a Windows 2000 environment. For example, a DOS-based workstation uses the *attach* command to initiate a connection to a NetWare server. In Windows 2000, of course, this is done through the My Network Places dialog box. Attach cannot be run through a Command Prompt window because the command prompt is not granted complete access to manage network connections. For the most part, the NetWare utilities used to monitor and manage a NetWare environment function normally on a Windows 2000 client.

NetWare Client for Windows

Client software is available from Novell for connecting computers to its NetWare servers. This software performs the same function as Client Service for NetWare and is installed via the CD-ROM provided with the NetWare operating system. When connecting your Windows 2000 computer to most NetWare servers, it is best to use the Microsoft Client Service for NetWare because of its tight integration with the Windows 2000 operating system. However, as noted earlier, Client Service for NetWare does *not* fully support the NetWare 5.x version of NDS. Therefore, it is necessary to load NetWare Client for Windows provided by Novell if you wish to provide full functionality.

Chapter Summary

- NetWare is designed for file and printer sharing on a network. Because it was one of the first network operating systems, it obtained a large share of the server market and by the mid-1990s functioned as the backbone for more networks than any other type of server.
- Although Microsoft servers make up a large portion of the servers installed today, many networks still rely on NetWare for their basic file and print services. For this reason, Microsoft includes NWLink, Client Service for NetWare, and other components to

ensure compatibility with NetWare systems. This is especially important in the case of Windows 2000 Professional because it's designed to function as a network client, not as a server.

- Early versions of NetWare utilized a bindery to store network resource configuration information. With the introduction of NetWare 4.0, Novell moved from storing this information in the bindery to using Novell Directory Services (NDS), a hierarchical enterprise solution for object-oriented storage of network resource information. By using Client Service for NetWare, Windows 2000 Professional is able to connect to both bindery-based and NDS-based NetWare servers. However, Client Service for NetWare does not support the new design of the NetWare 5.x NDS database. To connect to a NetWare 5 server, Novell client software must be installed on the Windows 2000 Professional client.
- The two main networking components that facilitate Windows 2000 Professional connectivity to NetWare servers are NWLink and Client Service for NetWare. Novell's primary protocol suite for network communication is IPX/SPX. The Internetwork Packet Exchange (IPX) protocol is a connectionless protocol that provides fast network transport between client and server. The Sequenced Packet Exchange (SPX) protocol is a connection-oriented protocol that provides guaranteed packet delivery but operates more slowly than IPX. NWLink is the Microsoft implementation of the IPX/SPX protocol suite. It is able to function within the NDIS specification to provide communication between computers on the network, including NetWare servers.
- After installing NWLink, you can configure the Ethernet frame type and network numbers to be used by the computer. The frame type specifies the structure of the packets being sent on the network. Windows 2000 will automatically detect the frame type currently being used on the network. However, there may be occasion to specify the frame type being used. When this option is selected, it is also necessary to specify the network number for communication. IPX and NWLink use unique network numbers to specify the location of the computers on the network. In addition, an internal network number, which can also be configured through the NWLink properties, is used to further identify the server computer and facilitate communication.
- Client Service for NetWare allows Windows 2000 computers to access network resources on NetWare servers. CSNW supports full access to NetWare file and print services, NetWare utilities, and the bindery and some NDS databases. CSNW adds a NetWare-focused redirector that acts as an extension of the file system. CSNW provides access to both character-based and GUI-based NetWare utilities. NetWare versions up to 3.12 utilize only character-based utilities, whereas later versions (4.0–5.x) utilize GUI-based utilities almost exclusively. NWLink and CSNW also support IPX burst mode, which enhances bulk data transfer over the network. CSNW is able to connect to both bindery databases and NDS trees. When users log on to bindery-based servers, they access the bindery database for logon authentication and security information, among other things. The primary limitation of bindery-based NetWare is that each server on the network has its own bindery database with user and group information.
- NDS is a hierarchical database that is used to store and maintain the information previously handled by the bindery. Unlike bindery networks, the NDS database is stored on

many servers on the network and provides a single logon to users. It also provides centralized administration of network resources, which was not possible with the bindery. An NDS implementation is called an NDS tree because of the hierarchical design of the database. An object's location in the NDS tree is called its context.

- Because CSNW integrates closely with Windows 2000, NetWare resources are accessed in the same way as other network resources—through the My Network Places dialog box. CSNW also provides support for NetWare-aware applications and utilities. All of the utilities that are needed by Windows 2000 are supported by CSNW. However, some of the DOS-based NetWare commands and utilities are not. The functionality provided by these commands is provided by other CSNW or Windows 2000 components such as My Network Places.

KEY TERMS

bindery — The database used by versions of NetWare before 4.0 to store network resource configuration information.

Client Service for NetWare (CSNW) — The Windows 2000 networking component that enables communications with NetWare servers.

Common Internet File System (CIFS) — An enhanced version of SMB used for file and print services.

context — The location of an NDS object in the NDS tree.

frame type — One of four available packet structures supported by IPX/SPX and NWLink. The four frame types supported are Ethernet 802.2, Ethernet 802.3, Ethernet II, and Ethernet SNAP.

Internetwork Packet Exchange (IPX) — Novell's connectionless protocol used for most network communication.

IPX/SPX — The protocol suite consisting of IPX and SPX. *See* IPX and SPX for more information.

NDS tree — The hierarchical representation of the Novell Directory Services database on NetWare 4.0 and higher networks.

NetWare Core Protocol (NCP) — The protocol used by CSNW to make file and print services requests of NetWare servers.

Network Basic Input/Output System (NetBIOS) — The method used by LANManager for network naming and transport functions.

Network Device Interface Specification (NDIS) — Microsoft's specification for network device communication with the operating system.

network number — The specific network identifier used by IPX for internal and network communication.

Novell Directory Services (NDS) — The hierarchical database used by NetWare 4.0 and higher servers to store network resource object configuration information.

NWLink — Microsoft's implementation of Novell's IPX/SPX protocol suite.

Open Datalink Interface (ODI) — Novell's specification for network device communication.

Sequenced Packet Exchange (SPX) — Novell's connection-oriented, reliable network communications protocol.

Server Message Block (SMB) — The protocol used by Microsoft clients to request file and print services from Microsoft servers such as Windows 2000 Advanced Server.

Review Questions

1. All versions of NetWare utilize NDS. True or False?
2. Which of the following is configured through its own Control Panel applet?
   a. NWLink
   b. CSNW
   c. TCP/IP
   d. NDIS
3. The Client Service for NetWare is not able to provide full functionality to _____ NDS trees.
4. Which of the following served as the basis for Microsoft's networking model?
   a. IBM LANManager
   b. Banyan Vines
   c. Novell ShareNet
   d. Windows NT
5. In addition to NWLink, _____ is installed to provide communication compatibility with Windows networks.
6. For IPX/SPX communication to succeed on a network, all computers must use the same frame type. True or False?
7. Which of the following Windows 2000 networking components are not available in the Professional edition? (Choose all that apply.)
   a. File and Print Services for NetWare
   b. Client Service for NetWare
   c. NWLink IPX/SPX Compatible Transport
   d. Gateway Service for NetWare
8. Novell's IPX/SPX protocol suite is based on _____ developed at _____.
9. The location of a network resource in an NDS tree is called its _____.
10. Which of the following NetWare protocols provides guaranteed packet delivery?
    a. NWLink
    b. IPX
    c. SPX
    d. NCP

11. In a mixed NetWare and Windows 2000 Server environment, which of the following networking components must be installed on the Windows 2000 Professional computer? (Choose all that apply.)
    a. Client for Microsoft Networks
    b. NWLink
    c. Client Service for NetWare
    d. TCP/IP
12. All NetWare 3.12 command-line utilities are compatible with the Windows 2000 Client Service for NetWare. True or False?
13. Although their functions can be accomplished through Windows 2000 utilities, such as Map Network Drive, CSNW supports NetWare _____.
14. Because IPX/SPX is not compatible with the Windows networking naming system, _____ is installed in conjunction with NWLink.
15. When configuring CSNW, which of the following provides a drop-down list from which you can browse available resources?
    a. default context
    b. frame type
    c. preferred server
    d. default tree

HANDS-ON PROJECTS

Project 8-1

To install NWLink:

1. If you have not already done so, log on to your Windows 2000 Professional computer as Administrator.
2. Right-click **My Network Places** and then select **Properties**.
3. Right-click **Local Area Connection** and then select **Properties**.
4. In the Local Area Connection Properties dialog box, click **Install**.
5. Select **Protocol** from the list of available components and then click **Add**.
6. Select **NWLink IPX/SPX/NetBIOS Compatible Transport Protocol** from the list, as shown in Figure 8-11. Click **OK**.

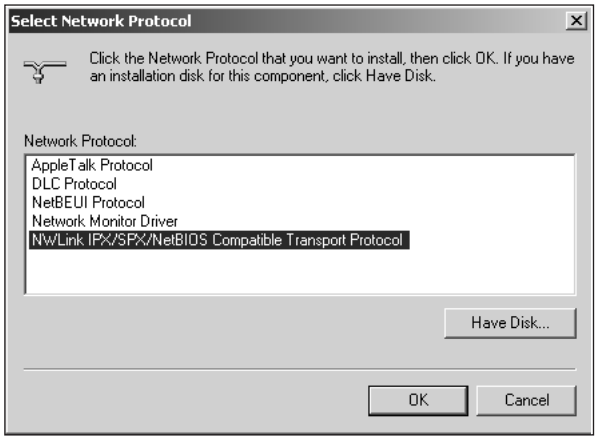

Figure 8-11 Select the NWLink IPX/SPX/NetBIOS Compatible Transport Protocol

7. Click **Close** to complete the installation. Note that you do not need to reboot the computer for this addition to take effect.
8. Right-click again on the **Local Area Connection** icon and select **Properties** to configure NWLink. Note that NWLink NetBIOS has been added to the installed components list.
9. Select **NWLink IPX/SPX/NetBIOS Compatible Transport Protocol** from the list and then click **Properties**.
10. Enter an internal network number for the computer. Use any combination of up to six numbers and letters A–F. For example, 1FAD or 1999A.
11. Click the down arrow for the **Frame type** dropdown list and select a frame. If you are in a classroom environment, select the frame type specified by the instructor.
12. Note that you must specify the network number for the selected frame. Enter a network number in the space provided. If you are in a classroom environment, enter the network number specified by the instructor.
13. Click **OK** twice to complete the configuration. Note that the changes take effect immediately. If you are in a classroom environment, ensure that communications are available to computers with the same frame type and network number.
14. Close the Network and Dial-up Connections window.

Project 8-2

To install and configure Client Service for NetWare:

1. If you have not already done so, log on to your Windows 2000 Professional computer as Administrator.
2. Right-click **My Network Places** and then select **Properties**.
3. Right-click **Local Area Connection** and then select **Properties**.

4. In the Local Area Connection Properties dialog box, click **Install**.
5. Select **Client** from the list of available components and then click **Add**. Note that the only client available to be installed is Client Service for NetWare.
6. Select **Client Service for NetWare** and then click **OK**.
7. When prompted, supply the default tree and context for your computer on the network or the preferred server to which the computer will connect. If you are in a classroom environment, obtain the tree and context information from your instructor.
8. Wait a moment while the configuration changes are made, then when prompted, click **Yes** to restart the computer.
9. Click **OK** to continue.
10. Click **OK** to continue.
11. After the computer has restarted, log on to your Windows 2000 Professional computer as Administrator.
12. Open the Control Panel by selecting **Start**, **Settings**, **Control Panel**. Note that the CSNW icon has been added.
13. Double-click the **CSNW** icon to open the Client Service for NetWare dialog box. Adjust the Print Options and Login Script Options as desired and click **OK**.
14. Note that you receive an information box telling you that the changes will take effect the next time you log in. Click **OK** to continue.
15. Close the Control Panel.

CASE PROJECTS

1. As the network administrator for a mid-sized R&D company, you are responsible for integrating Windows 2000 Professional into your existing network. Because of the engineering requirements for your company, you've decided to upgrade all 35 engineering computers to Windows 2000 Professional. You currently have two Windows NT Servers providing intranet support for your network, and seven NetWare servers, all version 4.0. You are not planning on upgrading the servers at this time, but it may be an option in the future. Discuss the steps you will take to ensure that all users who install Windows 2000 are able to connect to all existing network resources.
2. Using Case 1 as the basis for your design, create a plan to add a NetWare 5 server to the network. What changes will need to be made to the client computers to ensure connectivity to all resources?